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Homogenization of Milk Improves Nutrition of Nation by Increasing Consumption of Milk

Because prevention of nutritional diseases is now recognized as one of the foremost problems in the nation's health (1, 2), and because milk stands out as one of the most efficient protective foods, supplying essential vitamins, minerals, proteins, and superior fats (3, 4, 5, 6, 7), any influence which tends to increase per capita consumption of milk is of nutritional significance.

Development of modern dairy practice has brought a number of processing procedures which have contributed to increased milk consumption and consequently to better nutrition and improved health. Pasteurization of milk, the classic example, and the increasing of the vitamin D content of milk by irradiation or by other means, are two well-known and widely-practiced procedures which have helped bring the nutritional benefits of milk more consistently to more people.

The homogenization of whole fluid milk is another processing practice which has significant potentialities for increasing still further the consumption of fluid milk by persons of all ages because of certain merits of homogenized milk.

Homogenized Milk Defined

Homogenization is a mechanical process which breaks up the individual fat globules of the cream portion of whole milk into small particles, and distributes them evenly throughout the non-fatty portion. This more thorough "mixing" tends to prevent the separation of the fat from the rest of the milk, and consequently prevents the formation of a "cream line".

Babcock in a recent paper (8) referred to the former Food and Drug Administration definition of homogenized milk which is as follows:

> Homogenized milk is milk that has been mechanically treated in such a manner as to alter its physical properties, with particular reference to the condition and appearance of the fat globules.

and to that of the United States Public Health Service:

> Homogenized milk is milk which has been treated in such a manner that after a storage period of 48 hours tests of the 100 c.c. portion decanted from the top of a quart bottle of milk will not show a difference in fat content over tests of the remainder of the milk after thorough mixing exceeding 5% of the total fat content. For example, on 4% milk the difference shall not exceed 0.2%.

Babcock suggested a combination of the two definitions which would include the former Food and Drug Administration mechanical treatment description and the Public Health Service standard for minimum butterfat variation.

Special Merits of Homogenized Milk

Three major advantages of homogenized milk are:

Softer curd which results in more rapid digestion
Improved flavor
Even distribution of fat throughout the bottle

High-Pressure Homogenization Produces Soft-Curd Milk

The effect of homogenization on the curd of milk is described by Babcock as follows:

> That soft-curd milk can be produced by homogenization is now well established. The pasteurized milk from a commercial dairy, which the author uses in his work, has an average curd tension of 45.6 grams. The homogenized milk from the same dairy has an average curd tension of 6.7 grams. This milk is pasteurized by holding for 30 minutes at 143° F. It is homogenized at 2,500 pounds pressure. It should be mentioned that these curd-tension measurements were made by using an HCl-pepsin solution as a coagulant. This coagulant gives slightly lower curd-tension readings than are obtained by using the Hill coagulant. Experimental work, however, indicates that such a coagulant more closely simulates gastric conditions than does Hill's calcium chloride-pepsin coagulant.

Soft, Small Curd of Homogenized Milk Is Desirable for Infant Feeding

The value of homogenized milk for infant feeding has been studied extensively at Children's Hospital, Philadelphia. Results of the Philadelphia work were reported to the National Dairy Council by Wolman (9) who reported:

> The process of homogenization reduces the curd tension of milk and renders it of value in infant feeding. The same effect is produced in milk by boiling, and by the addition of albuminous substances such as malt products, barley and gruel. . . . Pasteurized homogenized milks have been proved to be as good or better as a food for infants than pasteurized milk boiled for five minutes in the home. Pasteurization and homogenization of whole milk under the conditions of this study results in the creation of a milk product possessing soft curd properties and small curd characteristics, features much to be desired in the artificial feeding of infants.

More Rapid Digestion of High-Pressure Homogenized Milk Demonstrated in Artificial Stomach

In a series of three experiments, in one of which were used an artificial stomach and artificial gastric juice, Babcock studied differences in rates of digestion of homogenized milk and unhomogenized milk. His results indicated that homogenized milk is more quickly digested than unhomogenized milk. Babcock described the digestion experiments as follows:

What evidence is there that homogenized milk is more digestible? It is impossible in experimental work to accurately simulate the human stomach. Indications of digestibility, however, can be obtained. We know that homogenization softens the curd of milk. By using latex bags as artificial stomachs, and by using artificial gastric juice, it can be shown that the curds formed by homogenized milk are smaller than those formed by unhomogenized milk. The fact that the curds are smaller in size naturally means that there is a greater surface on which the digestive juices will act. By the use of sieves and mathematical formulas it is possible to determine the approximate surface area of the curds formed.

In the case of the commercial milks previously mentioned, the author found that the curds from the homogenized milk had a surface area approximately 230% greater than the curds formed from the pasteurized unhomogenized milk. The curd sizes were determined after the milk had been in the artificial stomachs for one hour.

Indications of digestibility can also be obtained by digestive experiments in vitro. In such experiments, the author used a N/10 HCl-pepsin solution as a digestant. The digestion took place at a temperature of 37° C., and was measured for formol titration. Digestion took place at a pH of approximately 3.5. This work showed that both boiled milk and pasteurized homogenized milk digest more rapidly than raw milk. This was especially true during the first 15 minutes of digestion, when 76.5% and 56.5% more digestion took place with the boiled and the pasteurized homogenized milks, respectively, than with the raw milks from which they were prepared. It should also be mentioned that while the boiled milk showed a greater percentage increase in digestion during the first 15 minutes than occurred with the pasteurized homogenized milk, the percentage of increase in digestion did not drop off as rapidly for the homogenized milk as it did for the boiled milk. At the end of two hours, 15.4% more digestion had taken place in the homogenized milk than in the raw milk, whereas only 10.3% more digestion had taken place in the boiled milk than in the raw milk. At the end of five hours, digestion was practically the same for the raw and the processed milks.

Later, the author decided that actual digestion could be more closely simulated than was done under the above conditions. Proteolysis is most rapid at approximately pH 1.0, and is only slightly less rapid at pH 2.0, after which it decreases rather rapidly, and at pH 4.0 it is very slow. Furthermore, when sufficient HCl-pepsin solution is added to milk to lower the pH to 3.5 a somewhat flocculent curd is formed regardless of the character of the milk. The pH of gastric juice is reported to be 1.0. This does not mean, however, that the stomach contents have a pH thus low. When milk is drunk on an empty stomach, it would dilute the gastric juice in the stomach and the pH of the mixture would likely be raised to 5.0 or 6.0. Therefore a flocculent curd would not be formed

in the stomach, but continued secretion of the gastric juice would lower the pH until proteolysis took place.

The author, therefore, compared the digestibility of pasteurized and pasteurized homogenized milk as follows: The milk was first coagulated with a N/10 HCl-pepsin solution. A stronger HCl-pepsin solution was then added in sufficient quantity to lower the pH of the mixture to approximately 2.0. By so doing we had digestion taking place at a pH near the optimum for proteolysis and acting on actual curds simulating those formed in the stomach. The results obtained under these conditions showed the same general trend as those previously discussed. The rate of digestion, however, was more rapid and the differences between the two milks were greater than those previously obtained. Here again the greatest difference in the rate of digestion took place during the first 15 minutes. At the end of this time 171% more digestion had taken place with the pasteurized homogenized milk than with the pasteurized milk. At the end of the first half hour this difference had decreased to 125%, after which there was a rapid decrease in the amount of digestion of the two milks and at the end of five hours the amount of digestion was again practically the same for the two milks. The increased rate of digestion obtained by this latter method was undoubtedly due to the lower pH at which digestion took place. The greater difference in the rate of digestion is probably due to the fact that there is a greater difference in the character of the curds formed when the milk is coagulated at a higher pH prior to digestion.

These results indicate that homogenized milk is more quickly but not more completely digested than unhomogenized milk.

Absence of Cream Line Assures Full Proportional Intake of Butterfat

The even distribution of cream throughout the bottle of homogenized milk assures the consumer of getting the same proportion of cream as occurred in the original whole milk regardless of whether the milk comes from the top or bottom portion in the bottle or other container. A nutritionally significant point in this connection is brought out in Babcock's paper:

> . . . Undoubtedly one of its greatest advantages is the even distribution of fat throughout the bottle. This is probably of greater value in milk for schools and restaurants than in the home. This is well illustrated by the results of a survey in which milk was served to school children in half-pint bottles. It was found that an average of 5.6% of the milk was left in the bottle. This in itself would be insignificant, but when we consider that this 5.6% of the milk represented nearly 16% of the fat in the 4% milk served, it throws a little different light on the loss.

Many Consumers Drink More Homogenized Milk Because They Prefer Its Flavor

Flavor and palatability are so literally a subjective question of taste that they do not lend themselves to objective laboratory measurement. Flavor preferences, however, can be measured by the questionnaire survey method. A number of such surveys have shown marked preference on the part of many consumers for the flavor of homogenized milk. As a result of this flavor-pref-

erence, homogenization of milk makes available the nutritive values of milk to many persons who, because of taste idiosyncrasies, have heretofore drunk little or no fluid milk. Similarly, it tends to increase toward optimum nutritive levels the daily milk intake of many persons whose enthusiasm for the flavor of unhomogenized milk has been merely passive. This aspect is of especial importance in the feeding of children where every influence that causes them to drink a liberal quota of milk has health value.

Homogenized Milk Preferred by Many for Feeding Adults, Children, and Infants

Although improved flavor, more rapid digestion, and even distribution of cream are the primary advantages of homogenized milk, much of the popularity of homogenized milk among consumers is based on practical aspects as well. In answering the question of causes of the increasing popularity of homogenized milk, *The Dairy World* (10) referred to a recent survey made by the Dairy Department of the University of Illinois where homogenized milk has been studied for several years. *The Dairy World* summarizes the results of the survey as follows:

> The University Creamery operates a retail milk route in connection with its research and teaching activities. At the present time 50% of the milk bottled is homogenized, although no special effort has been made to increase its sale. Through a questionnaire an attempt has been made to learn the reason for the popularity of homogenized milk amongst its users. Some of the reasons given were as follows:
>
> 1. Absence of cream adhering to bottle cap.
> 2. No mixing necessary.
> 3. Tastes richer.
> 4. Answers a large number of purposes.
> 5. Can be used on cereal and in coffee.
> 6. Easy to prepare for baby feeding.
> 7. The last glass is as good as the first.
> 8. No cream rises to top of glass standing in refrigerator.
> 9. There is no temptation to remove the cream.
> 10. There is no loss of cream in scum after boiling.
> 11. Feedings prepared for infants in advance do not have to be remixed when used.
> 12. Quicker to serve.
> 13. Makes better-flavored gravy and soup.
> 14. Improves the texture of many foods.
> 15. Our youngsters refuse to drink any other kind of milk.
> 16. Makes fine milk drinks.
> 17. It makes good custards.
> 18. As a result of my children's drinking more of this milk, all have gained weight.
> 19. Nipples on bottles do not stop up and baby gets proper proportion of fat.
> 20. We believe it a perfect product.
> 21. An infant born in October was fed prepared powdered milk but was unable to properly digest fat. Was then fed homogenized milk which has been digested easily and infant has been gaining weight steadily.
> 22. When homogenized milk freezes it does not churn out as does the regular milk.

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Homogenized Milk Is Typical of Research Translated into Products

Homogenization is a process which owes its development to many research and technical workers in many laboratories and institutions. It is an example of the translation of research and of technical advances in milk processing into commercially available products. The dairy industry, realizing the importance of such developments to both the national economy and the nation's health, has consistently sponsored advanced research and invests large sums annually to make possible its practical application.

All this has been and continues to be of primary importance in promoting a higher level of public health. Besides furthering improved methods for protecting the quality of milk and milk products the dairy industry, through research, is multiplying the forms of milk and milk products available to all types and groups of consumers. This makes it possible for more people to share the inherent nutritional benefits that nature so liberally brings together in a single food product—milk.

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